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Attenuation and dynamics of pharmaceuticals in a small German stream

Uwe Kunkel (1) and Michael Radke (2)

(1) University of Bayreuth, Department of Hydrology, Bayreuth, Germany (uwe.kunkel@uni-bayreuth.de, Fax: +49 921 552366), (2) University of Bayreuth, Department of Hydrology, Bayreuth, Germany (michael.radke@uni-bayreuth.de, Fax: +49 921 552366)

Pharmaceutical residues are commonly detected organic micropollutants in the aquatic environment. Their fate in rivers and the importance of individual attenuation processes (photolysis, biotransformation, and sorption) is still incompletely understood. Previous studies indicated that in rather deep and turbid rivers these potential processes not always result in a significant attenuation of pharmaceuticals. Therefore, we performed experiments at a stream with less turbid water and an expected increased exchange of river water and sediments to check dynamics and attenuation in such streams.

Experiments were carried out at the stream Gründlach, near Nuremberg, Germany. Composite samples were taken at both ends of a river stretch of approximately 12 km length located downstream of a sewage treatment plant. Moreover, pore water samples were taken and in-situ photolysis experiments at several sites within the river stretch were performed. The concentration of 15 pharmaceuticals was analyzed with HPLC-MS/MS after solid phase extraction.

Pharmaceutical concentrations varied at the first sampling site due to variable proportions of sewage water in the river. Concentrations and loads at the downstream sampling site were lower for most pharmaceuticals. In comparison to carbamazepine which was persistent, metoprolol was attenuated within the river stretch. This attenuation can be attributed to sorption and/or biotransformation since it was not susceptible to photolysis. For diclofenac, photolysis in unshadowed parts or the river stretch could also be relevant as we determined an in-situ photolysis half-life of a few hours. Ibuprofen was only detected during rainfall events, indicating an input of untreated wastewater through combined sewer overflows.

Preliminary results of this study suggest that attenuation of certain pharmaceuticals in small streams can be relevant. Even within short river stretches pharmaceuticals can be eliminated due to the more intense exchange of river water with the sediment compartment and due to a higher efficiency of photolysis compared to large rivers.